

# solplan review

the independent newsletter of energy efficient building practice

the drawing-room graphic services ltd.  
box 86627 north vancouver b.c. V7L 4L2

No. 14

April-May 1987

## INSIDE....

Current good quality construction requires that ventilation be incorporated. Fully ducted mechanical heat exchanger systems are now commonly used by low energy builders.

John Timusk from the University of Toronto has been looking at a new concept, known as the *dynamic wall* which incorporates the wall itself into a functioning heat exchanger. It may provide an alternative method to provide ventilation, and revolutionize how we build houses.

The Swedish housing industry is acknowledged to be an advanced high-tech industry. It is starting to make a move to sell its technology into North America. It offers, at the same time, an opportunity and a challenge to our housing industry.

Consistent airleakage testing is important. We review the acceptable way to prepare for the test, and new procedures being accepted by the R-2000 Program.

Other items we review include a campaign being launched south of the border raising questions about the safety of fiberglass insulation products; results of a retrofitting study conducted in Calgary, which indicates where to spend time and effort to tighten up a house; information about a new gas fired boiler, and a new HRV.

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## THE DYNAMIC WALL



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Richard Kadulski

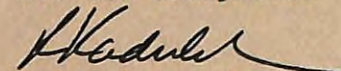
## FROM THE PUBLISHER

We've noted with some concern that the building industry is quick to protest against changes to codes and regulations. They are instituted by regulatory agencies to protect the public from unscrupulous members of the industry (which the industry may be unable or unwilling to discipline themselves). However, when the opportunity is given to participate, too often there is little response from the industry.

The latest example of this is the revisions in the 1985 Edition of the National Building Code of Canada, as they relate to sealing and mechanical ventilation of small buildings. As we've pointed out recently, there are some serious questions about the implementation of these new requirements - but the general principles behind them are sound.

The industry, through the CHBA, has just now started to react. They raise a number of valid concerns about how these are to be implemented. The CHBA would like to stop implementation of any changes until the industry is ready. However, where was the industry several years ago when proposed changes were first introduced and circulated for comment? How is the industry going to be prepared for the implementation of the new requirements?

When is it going to be ready to accept new changes? Buildings are already being built to a standard that ensures the rapid deterioration and an unhealthy environment for the occupants!

  
Richard Kadulski  
Publisher

## COMING EVENTS

**SOLAR 87: July 11-16, 1987**

The annual conference of the Solar Energy Society of Canada is being held jointly with the American Solar Energy Society in Portland, Oregon. This is an interdisciplinary conference covering all forms of solar applications. In addition to 4 days of technical sessions, there will be a series of in-depth workshops for architects, builders, designers, engineers.

Sessions will include Energy Efficient manufactured housing, energy analysis computer tools, daylighting design, passive cooling of buildings, advanced passive solar design, Super Window technology, as well as tours.

For details and registration forms, contact **Solplan Review**. Preregistration deadline is June 12, 1987.

**LEBCO SYMOSIUM at SOLAR 87**

The session will provide an opportunity to review the state of the art of low energy construction, and to exchange information with builders and designers in the United States.

Speakers scheduled include:

**Oliver Drerup:** "Building Low Energy Homes for the Chemically Ultra-sensitive - One builder's experience"

**Ken Cooper:** "Energy Efficient Houses for Canadian West Coast conditions"

**Rob Dumont:** "An Overview of Low Energy Housing Developments in Canada since 1973"

**Mark Riley:** "Super Energy Efficient Homes Project: An Update on the R-2000 Program"

**LEBCO SYMPOSIUM - JULY 11-16, 1987  
PORTLAND, OREGON**

SOLPLAN REVIEW is published 6 times per year by The Drawing-Room Graphic Services Ltd. P.O. Box 86627, North Vancouver, B.C. V7L 4L2. Tel: 604-689-1841

ISSN: 0828-6574 Printed in Canada

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Second Class Mail Registration No. 6855

Date of Issue: May 1987

## VENTILATION ALTERNATIVES: THE DYNAMIC WALL

*The Dynamic wall is a new concept in frame construction. It raises many questions. However, it offers a new way of looking and building wood frame housing. Is it too good to be true? We leave it to you and further research to decide.*

*John Timusk, who has built his own retirement home using the system, has been doing much pioneering work on the concept. He is the Director of the Centre for Building Science, University of Toronto.*

### Natural ventilation

The R-2000 builder knows about the importance of ventilation. Traditionally, ventilation was supplied by natural (or passive) means. A pressure difference pushed or pulled air through openings in the building envelope. Neither pressure nor openings are controllable.

Holes in the envelope are accidental. The total leakage area will vary from house to house, and season to season. (Houses tend to "close up" over the winter when moisture accumulated in the walls closes cracks).

Pressure to drive air leakage (in or out) is even harder to control. It depends on temperature difference between inside and outside, wind, and air exhausted through chimneys, dryers or other appliances.

Problems with natural ventilation are many: in leaky houses we have more than we need (and can afford); in tight houses we have too little; in cold windy weather we have too much; in summer and in calm conditions, too little. Even if there is enough ventilation, it is not properly distributed. Fresh air comes in through windward walls, and through lower parts of the building. Windward and downstairs rooms get the fresh air while the spent air leaves through upstairs and leeward room walls.

Opening an upstairs window on the leeward side will not bring in any fresh air through the windows - air from the rest of the house will be exhausted through it. (An open window may have worked well in old unheated houses, but not in tighter, heated buildings).

In traditional construction with combustion appliances, there was generally

adequate ventilation as the chimney often overpowered wind and house stack effects, pulling ample fresh air into most areas of the house. As long as houses had a working chimney for the central heating system, air quality problems were rare as the chimney acted as a powerful fan, exhausting air from the house. Air exhausted through the chimney had to be replaced. This happened through the walls and even upper floor ceiling. All the rooms received fresh air. Exfiltration through the walls was seldom a problem (moisture damage due to concealed condensation is due to exfiltration).

Baseboard heated and naturally ventilated houses experience moisture and air quality problems because they lack the working furnace chimney. They also do not have the internal air circulation offered by a central heating system.

Recognizing that natural ventilation is not dependable and most of the time an energy waste, the trend is toward eliminating natural ventilation by making the building envelope as tight as possible and providing fresh air into each room mechanically.

The tighter we build walls, the better it is for the walls and the owner's bank balance. With air leakage cut to a minimum, one can now concentrate on providing the necessary fresh air to all the rooms.

### Ventilation Options

There are several options available.

**Balanced ventilation** is the most common approach used today. It generally makes use of the heat recovery ventilator. Fresh air is preheated by recovered heat from the exhaust stream. The two flows are balanced.

Natural infiltration and exfiltration may occur depending on wind pressures and stack effects present on the house.

**Positive pressure.** Here the ventilation air is brought in through a single intake where it can be tempered before distribution through the house. Heat is not recovered.

In positively pressurized buildings, there is a danger that warm humid air exfiltrating through openings in the building envelope may deposit moisture in the wall

cavity, leading to moisture problems in the wall structure.

Pressurization of a building may be appropriate where it is used to control and prevent the entry of contaminants present in the building envelope (e.g. off-gassing from urea formaldehyde or radon gas).

**Negative pressure.** This is the typical naturally ventilated house, except the working chimney is replaced by an exhaust fan to induce negative pressures. Under negative pressures, heat recovery and control of the rate of ventilation is possible. Wind and stack action still have an effect, but with a tight envelope, the exhaust fans should generally be able to overpower them.

The pressure drop required will depend on the rate of exhausting, and the tightness of the envelope.

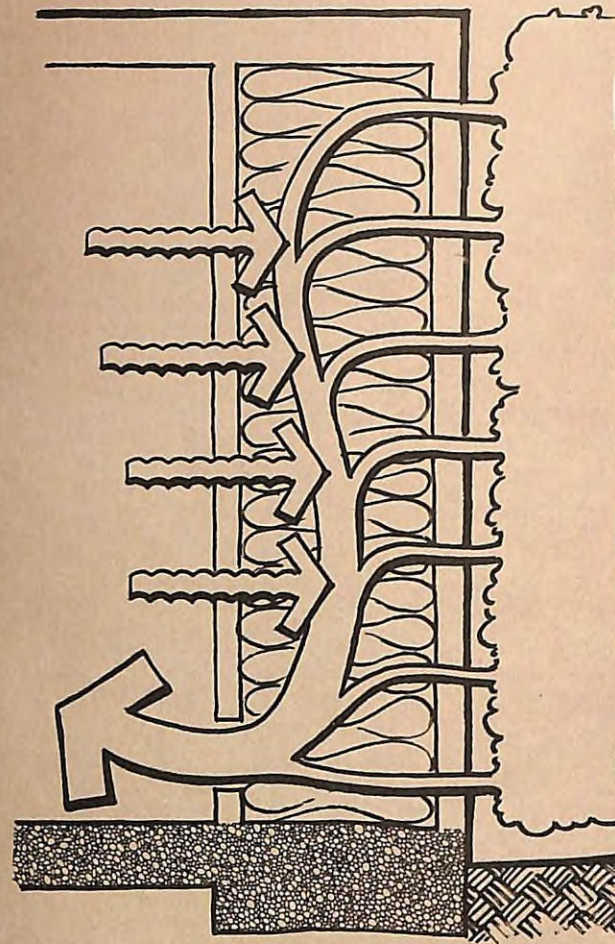
The **dynamic wall house** is a special case of the negative pressure house: air is drawn in through the walls and exhausted by a fan. This way there is better control over the amount of air exhausted, including during warm weather when the furnace would not be on. (Fresh air is needed at all times of the year!)

As the name implies, something special has been done to the walls. They are built to provide fresh air to all the rooms. The fresh air is heated at the expense of heat that would otherwise be carried out through the wall. In other words, the wall is built to act as a heat exchanger.

Insulation works on its ability to trap still air. When cold air flows through the insulation, the interior can be cooled to the point that in extreme cases condensation, mould and mildew can form.

The wall also loses heat through the wall. The theory behind the dynamic wall concept says that if a gentle stream of exterior air is drawn in through the insulation, the air can be warmed up by the heat otherwise lost to transmission through the wall. If incoming air is needed for ventilation, and would have to be heated, the decrease in heat loss through the wall is an energy saving.

Insulation which transfers heat to the ventilation air is called dynamic insulation and a wall utilizing this principle



can be called a dynamic wall.

To be dynamic, a wall has to be constructed so that the ventilation air enters uniformly across the wall surface. Since the available wall surface area is very large, the rate at which air has to be drawn in per square meter of wall is very small. At normal ventilation rates the speed at which the air moves through the wall surface is less than a millimeter per second.

To control the rate of air entry into the walls, an air diffusion membrane is placed under the siding and over the insulating sheathing layer. This membrane is water permeable and modestly air permeable, effectively forming a breathing air barrier (somewhat a contradiction in terms - so the term air diffusion barrier is being suggested).

The important thing about the air diffusion membrane is that it has to be applied so tightly that when air is exhausted from the house at the specified R-2000 ventilation rate, the house pressure is lowered sufficiently to create a negative pressure

which largely overpowers wind and stack (indoor warm air buoyancy) effects. In this manner all rooms with exterior walls will receive fresh air more or less in proportion to their wall areas.

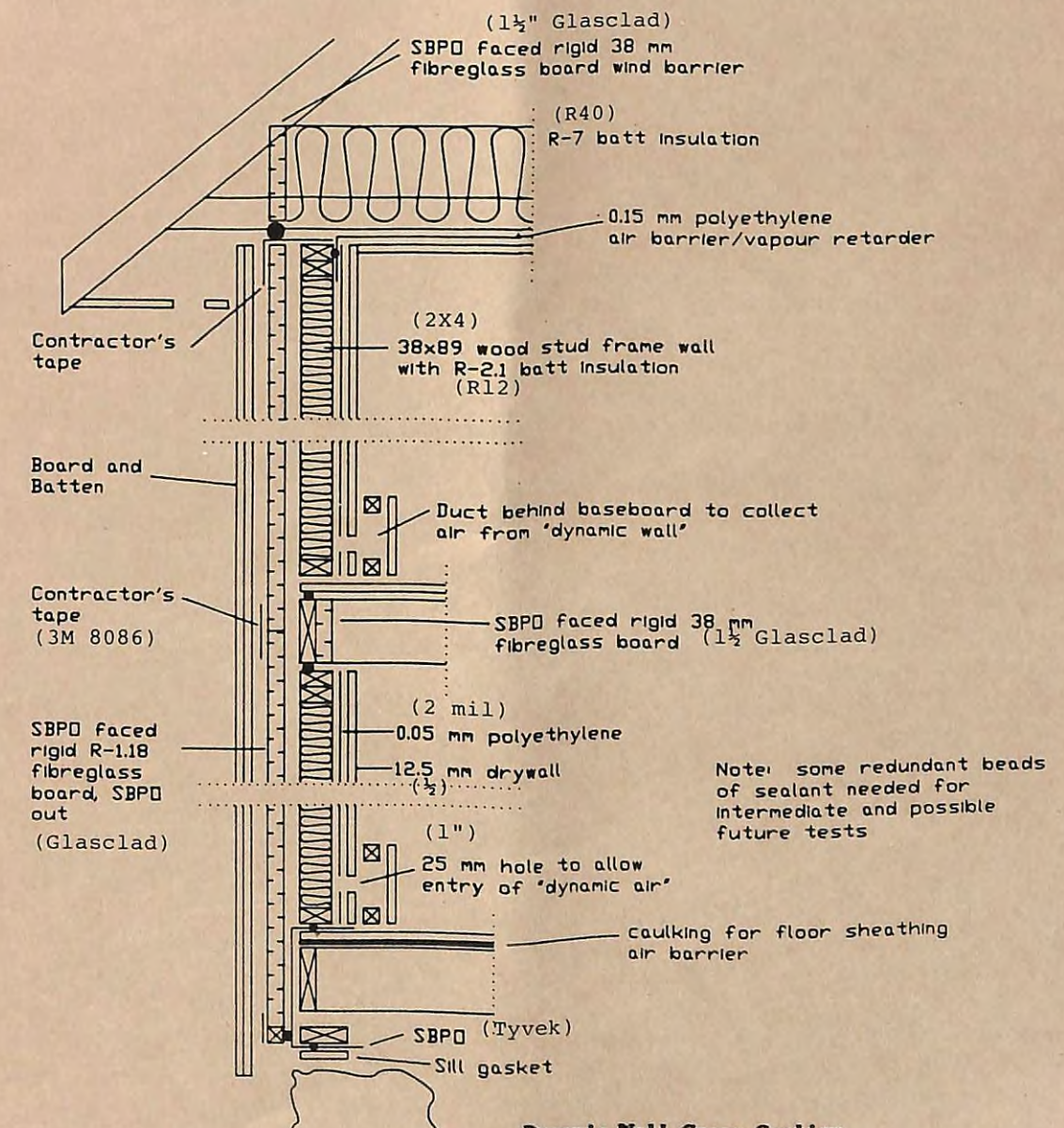
As it takes some 10 minutes on the average for the air to complete its journey through the wall, sufficient time is provided for it to be warmed up. In John Timusk's house, monitored by the University of Toronto, test data showed the air recovered about 80% of the heat lost through the wall.

On the interior face of outside walls, small holes are drilled in the wallboard, behind the baseboard.

As the air warms up in the wall cavity, its ability to hold moisture increases, so the ventilation air is also able to absorb moisture from the wall, such as moisture of construction (green lumber used during construction) rain penetration, etc. In effect, a wall which is ideally suited for wet climates.

Exhaust air is picked up from bathrooms and kitchen at the R-2000 rates.

The heating of incoming air is at the expense of heat which would otherwise be lost. Estimates are that in a dynamic wall house about 60% of the ventilation air can be classified as dynamic air. (With about 80% of its heating). Thus of all the ventilation air about half was heated for



**Dynamic Wall Cross Section**  
Air is drawn through the wall, preheated and admitted into the house behind the baseboard

free. In the average small Canadian house (in a 4000 DDC climate zone) the annual energy savings could amount to about \$130 (at \$0.05/kwh).

The energy recovery is roughly equal to that obtainable from a heat recovery ventilator. However, the capital cost for the mechanical equipment is much lower for the dynamic wall.

In the dynamic wall house a further energy recovery option is available: heat from the exhaust air can be recovered by means of a heat pump. If this heat is put into domestic hot heater, the exhaust air heat is recovered year round.

Where air conditioning and dehumidification is needed during the summer the flow direction can be reversed so that the house becomes pressurized. However, the heat pump still pumps heat in the same direction - from the air stream into the water tank. This makes for a cheaper and more reliable heat pump.

In summary, the dynamic wall house operates basically like the furnace heated house with an active chimney. It is operated under a slight negative pressure, ventilation air is preheated as it passes through the walls, and enters all the rooms directly. Energy savings are realized as the air is preheated at the expense of heat that would otherwise be lost. Wall construction, if anything, is simpler than that of the traditional R-2000 house.

If it is so good, does this mean everything that has been done recently is now obsolete, and we don't need to build tight houses any more? The answer is a firm NO!

Even in the dynamic house, you still need to have a tight envelope, so that exhaust can be controlled. It's that the openings and the 'slack' in the building is carefully designed.

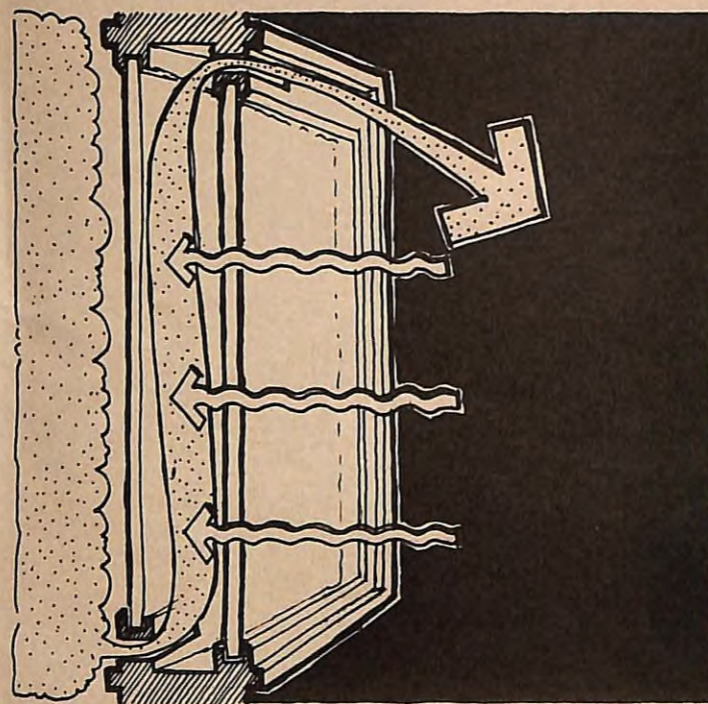
There is still much research to be done. The house built by John Timusk is meant to be a permanent residence, but it has not yet been occupied, so the testing has been done, essentially with the house in an unoccupied mode. Further monitoring is needed under normal occupancy to see if this concept performs as well as expected.

Combustion appliances within the house, and especially fireplaces, could cause some problems, and make the dynamic wall concept unworkable (or at least less efficient).

Another consideration is what is the possibility of the pores in the exterior wall getting 'plugged up' especially if the house is located in a dusty urban environment. Perhaps this is not a factor, but it might be a problem. We know of cases where HRV inlets have been plugged solid by dirt accumulating against insect screens. Would such an environment have similar impacts on a dynamic wall?

As in any exhaust only system, there is less control on filtration and quality of the incoming air if that is a concern (e.g. allergy sufferers).

Elsewhere in this issue we report on concerns being expressed about the safety of fiberglass insulation. If these are legitimate, then the fiberglass insulated dynamic wall could help the spread of fibers into the house. However, some permeable rigid insulation boards (such as beadboards) may be sufficiently porous to allow it to function in a dynamic fashion.



Research work being done on dynamic windows - if you could not or did not wish to modify the wall construction, modified windows might work equally. Perhaps not as efficient, but equally acceptable.

## SWEDISH FACTORY CRAFTED HOUSING

A conference on Swedish Factory Crafted Housing was held recently in Tacoma, Washington. Its object was to explore possible applications, technology transfer and cooperation between the Washington State housing industry and the Swedish housing industry. It was not set up as a sales meeting, but as an introduction to Swedish factory crafted housing technology, expose Swedish housing systems and allow for interaction between Swedes and their US Northwest counterparts.

The housing and forest products industries are important to the economy of the US Pacific Northwest which has a strategic location on the Pacific Rim. Energy efficiency is a matter of public policy and consumer preference.

The Swedish housing industry already is active in Europe, selling housing components to Germany, Switzerland, England as well as as the USSR, Japan, Algeria, Vietnam, and the Eastern seaboard of the USA. The nature of presentations (high powered, slick video presentations, high profile representatives of government, research and industry) indicates that the Swedish industry is ready to make a major move into North America.

Some Americans are looking at the potential of this technology with a view to re-export it to other Pacific Rim countries (taking advantage of the US northwest forest products).

### What is so unique about Swedish housing?

First and foremost it is a management systems approach to house construction. Houses are built from components, not unlike the way the automobile industry assembles vehicles.

Swedish technology has produced an efficient system capable of crafting customized houses that are easily assembled on a permanent site to deliver year round comfort at a low monthly cost. It is a wood based technology where most building components are manufactured in factories under tight quality control, often using highly automated computerized yet very flexible equipment and processes and a skilled workforce.

The system is flexible. While each manufacturer has a catalogue of standard designs, only 20% of houses are stock

catalogue designs, while 40% are modified, and 40% are totally custom designed.

Allowing for house size and climate, Swedish homes use about one half the heating energy of their US counterparts - this despite the Swedish preference for higher indoor temperatures.

The Swedes have acquired a reputation for quality. House quality is not so much in the "features" of the home (although their houses can be designed to accommodate the features associated with quality in North America). Rather, the quality with which they are concerned is the largely hidden quality of materials and workmanship which results in a long-lasting, low upkeep energy efficient home.

Anyone familiar with the R-2000 Program will appreciate and understand the technical issues that are being incorporated in the construction techniques.

Kiln dried lumber is the norm, used in all houses. A measure of the quality control attainable is that typically tolerances for housing components are several millimeters for large building components.

A mandatory 10 year warranty is being introduced. It is a third party policy (underwritten by an insurance company), and includes coverage of the ventilation system.

Mortgages are available to periods up to 50 years. The underlying philosophy is the affordability of housing, as assessed by total monthly payments (including principal, interest, taxes, energy and maintenance costs).

90 % of all single family houses in Sweden are factory crafted (approximately 1/2 of all houses are single family, a total of some 15,000 units per year).

The average house is built in about 700-1000 man hours over 30 days (250-300 in the factory, the balance on site services, erection and finishing). By comparison, the average stick-built house in North America takes about 1500-2000 man hours over 90 days. The Swedish house is typically closed to the weather in 1 day, and the finishing (including mechanical systems) are site installed.

Although the housing factories belong to large companies, it is the small contractor that does the erection and finishing of the house. In fact, the small contractor is

generally the salesman for the manufacturer.

It is of interest that the marketplace is ahead of code standards. High energy prices in combination with the Swedish consumer's preferences for quality has created strong competition in the housing industry. This results with most Swedish builders constructing houses that are more energy efficient than required by the building code.

The building code is based on long term life cycle costing analysis (20-25 years) taken from a national perspective - not the short term, individual scale. The code is performance based, and requires minimums of: R33 walls; R47 roof; R28 floor (slab on grade or crawl space) R2.8 windows; R5.7 doors. The tightness required is 3.0 ACH @50 Pa. and mechanical ventilation standards call for 0.5 ACH

Why should Swedish industry developments be of interest to us?

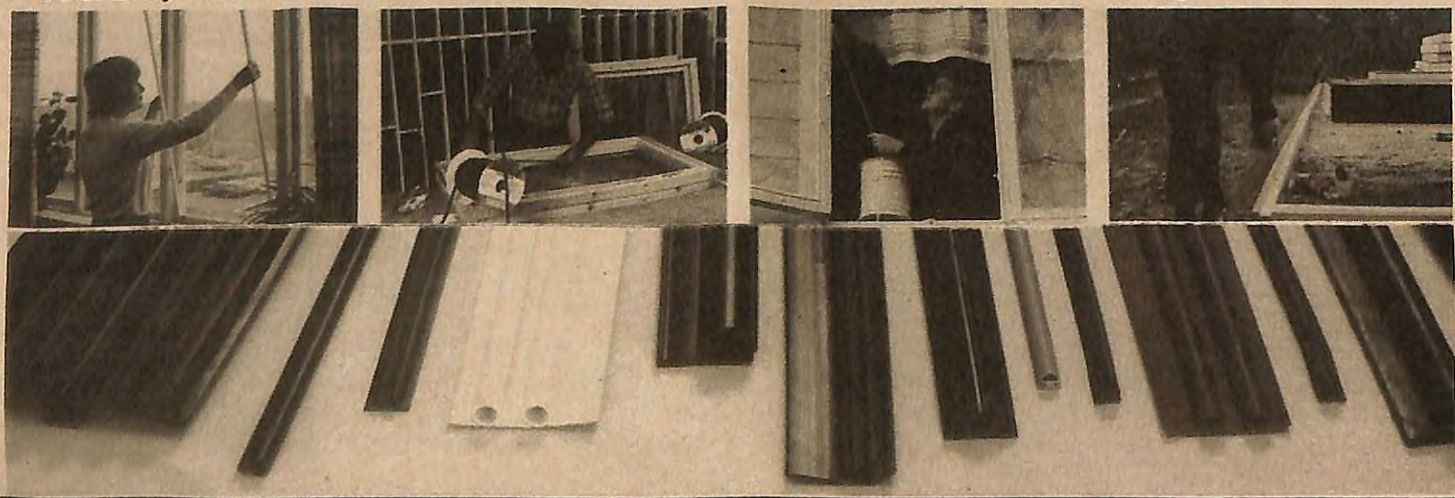
Lately there has been much interest generated among progressive elements of the US housing industry about what others are doing (R2000 is highly regarded in the USA). The Swedes are ready to take advantage of it. While some housing units are being shipped to the USA, it is recognized that shipping of whole house components is

SWEDISH BUILDING PRODUCTS: AN EXAMPLE

An example of the kind of quality and attention to detail that is paid by the Swedish housing industry, is to look at some of the products they work with.

Any builder who has uses the airtight drywall approach, or has considered doing so, will appreciate the difficulty in getting good quality, durable gasketing products at an affordable price. Most products we have seen builders trying to use have a questionable utility.

Probably the best material is EDPM rubber



not practical. Rather, joint venture investments to sell the technology and management systems developed in Sweden are being contemplated.

Our feeling is that we will be seeing and hearing much more about Swedish housing. It presents an opportunity and a challenge for the Canadian housing industry. The opportunity is to build on the work being done through the R-2000 program, to take advantage of technological developments in the housing industry.

We have already heard of one entrepreneur who is planning to set up a plant (in conjunction with Swedish interests) in Ontario later this year.

The challenge is to maintain and advance further in those areas we in Canada have refined.

It is inevitable the site built, 100% stick built construction is going to become obsolete for the majority of our construction. If we are to keep our industry vibrant and on the leading edge, we have to improve our industry. If our industry does not pick up the challenge offered by the Swedes, we may well end up on the sidelines as we will be forced to purchase new technology from others (as has happened all too often in Canada)!

but there are few sections available suitable for the building industry. The automobile industry uses many sections, but they are not suitable for housing applications.

The illustrations shown here are taken from a Swedish building products brochure - it illustrates a small portion of the many sections and sizes available from a single manufacturer that are used on a regular basis. Each makes an effective seal and has a much longer service life than most conventional methods currently used.

VENTILATION: HOW MUCH IS ENOUGH?

Ventilation in residential buildings is still a new field, and much monitoring work is underway. There is considerable debate going on about what constitutes acceptable ventilation levels, as we've discussed in recent issues of SOLPLAN REVIEW.

Generally, standards are set at a level that will avoid any potential liability problems for the agency setting the standard. As a result, there is a tendency to demand higher rates than may be strictly necessary (to protect everyone's backside!).

We thought this may be an appropriate moment to compare ventilation requirements of different building programs and building codes in 4 different countries.

Each agency uses a slightly different approach to determine ventilation requirements. They are difficult to compare directly, as some use a total volume to calculate ventilation, others based on

number of rooms. For ease of comparison, we have assumed a standard 3 bedroom, 1200 sq.ft. house with kitchen, living, dining room and 2 bathrooms plus basement.

France: latest building code requirements

Canada: NBC: 1985 edition of the National Building Code of Canada. The relevant sections are not being implemented uniformly in all jurisdictions at this time.

Canada: R-2000: current Technical Requirements of the R-2000 program.

USA: BPA BPA is the Bonneville Power Administration in the Northwestern U.S. Their Super Good Cents Program is similar to the R-2000 program, except that it is more prescriptive in nature. It has 2 levels. We have noted the most restrictive requirements.

Sweden: the latest building code requirements.

	FRANCE	CANADA R-2000	CANADA NBC	USA BPA	SWEDEN
AIRTIGHTNESS REQUIREMENT	NONE	1.5ACH @50 PA OR .7 CM <sup>2</sup> /M <sup>2</sup>	NONE	1.8ACH@50PA	3.ACH @50PA
FRESH AIR SUPPLY CAPACITY	103 CFM	150 CFM	163 CFM (.5ACH)	114 CFM (.35ACH)	163 CFM (.5ACH)
MINIMUM CONTINUOUS VENTILATION	80 CFM	100 CFM	NONE	81 CFM (.25ACH)	
MIN CONT VENTILATION FOR AUTOMATIC MODULATING SYSTEM	15 CFM				
EXHAUST CAPACITY	103 CFM	200 CFM	163 CFM (.5 ACH)	200 CFM	
DISTRIBUTED VENTILATION REQUIRED	YES	YES	NO	FRESH AIR TO BEDROOMS + 1 GENERAL LIVING AREA	YES
INDOOR AIR QUALITY SOURCE CONTROL	NO	NO	NO	YES	YES

TABLE 1. COMPARISON OF VENTILATION REQUIREMENTS IN DIFFERENT JURISDICTIONS

## AIR LEAKAGE TESTING

A well built house will have an airtight building envelope. This ensures that the house is draft-free, and minimizes potential deterioration of the building structure. To ensure that the tightness of houses is measured consistently, standards have been developed which spell out exact procedures that must be followed.

Every house has a number of openings in it, some intentional, others not. To determine the tightness of the building, we are interested in knowing the total area of the unintentional openings. For this reason, the testing standard spells out acceptable procedures to follow.

Generally, intentional openings can be sealed up for the test. The standard procedure for determination of airtightness of houses by fan depressurization indicates that allowable preparation of intentional openings is as follows:

FIREPLACE FLUE	NO PREPARATION
FIREPLACE DAMPER	CLOSE
FIREPLACE DOORS	CLOSE
FIREPLACE COMBUSTION AIR INTAKE DAMPER	CLOSE
FUEL FIRED FURNACE AND/OR STOVE FLUE	SEAL
FURNACE COMBUSTION AIR INTAKE DAMPER	CLOSE
FURNACE DRAFT CONTROL INTAKE DAMPER	CLOSE
FLOOR DRAINS	FILL
PLUMBING TRAPS	FILL
EXHAUST FANS WITH MOTORIZED DAMPER	CLOSE
EXHAUST FANS WITHOUT MOTORIZED DAMPER	NO PREPARATION
HRV DESIGNED TO RUN CONTINUOUSLY INTAKE/EXHAUST	SEAL
DRYER VENT	SEAL
WINDOWS/DOORS	LATCH
WINDOW AIRCONDITIONERS	SEAL
ATTIC HATCH	CLOSE
FUEL FIRED FURNACE &/OR STOVE FLUES IN ENCL- USED FURNACE ROOM*	NO PREPARATION
EXHAUST SYSTEM COMMON TO MORE THAN ONE UNIT	SEAL
FUEL FIRED HOT WATER SYSTEM FLUE	SEAL

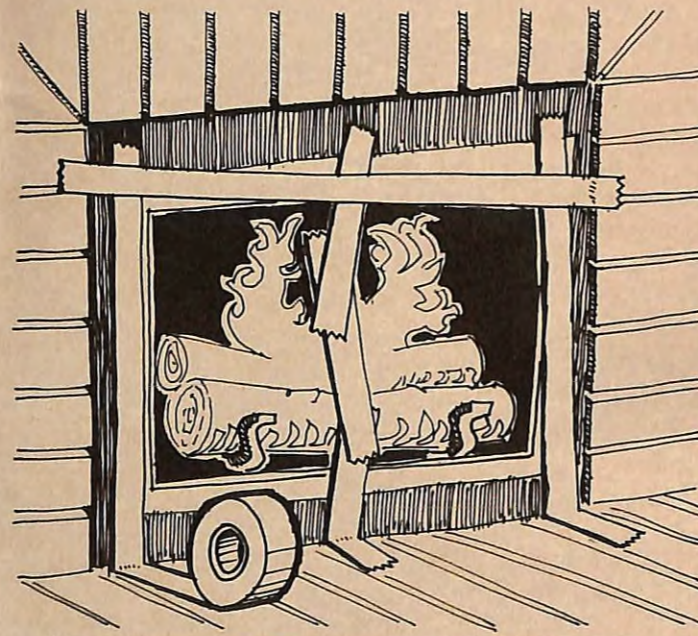
It has been known for some builders and testers to seal up all openings for the pressure test - even doors!

A major problem area has been fireplaces. While it is required that they be equipped with tight-fitting doors, anyone familiar with them is aware that very few standard fireplace doors really are tight. By design most are leaky.

One reason for this is that glass commonly used must be allowed to expand when heated. In addition, one means of cooling the glass is to allow a thin film of air to circulate about the glass. Only special ceramic glass is capable of taking the temperatures that these doors can be exposed to, but they are more expensive, and few fireplace doors use it. (On zero clearance fireplaces, the thin air film also helps to keep temperatures of the firebox lower).

As a result, the fireplaces can be a major source of air leakage into the house.

The R-2000 Program has changed acceptable testing practices. It is now allowing the sealing of fireplaces during the air test. At first glance it may appear to be cheating the intent of the pressure test



\* An enclosed furnace room is a room expressly built to contain a furnace and/or stove, with a combustion air intake to the outside of the building, and to prevent air flow to and from the remainder of the building.

of the house. However, the intent of the air test is to determine the tightness of the building envelope, and to see if there is a need for additional make-up air.

If you have a leaky fireplace (unsealed) the fan door air leakage test may determine that the house meets the requirements, and does not require additional make-up air for other exhaust appliances. However, most of the make-up air may actually be coming through the leaky fireplace doors. Obviously, it is not desirable to use the fireplace as the make-up air source. By sealing the fireplace, the pressure test actually measures the total of openings through the envelope only.

This procedure, which is now acceptable, still does not address the issue of just how tight 'tight' doors should be (There is no standard to cover this yet). However, we understand that work is underway to establish an acceptable tightness standard for fireplace doors.

By sealing the fireplace doors, it could be possible to approve a house with leaky doors which could cause potential health risks to the occupants (by allowing excessive amounts of leakage) from the fireplace if there is any backdrafting.

### Preferred testing approach:

An acceptable alternative that has been proposed by the B.C. R-2000 Advisory Technical Committee and, we feel, is more appropriate is to do 2 pressure tests. This procedure resolves the technical and safety concerns with fireplaces.

The first test would maintain the integrity of the R-2000 tightness requirement as it has been done up to now. This test should be done as it has been done up to now. (i.e. without sealing fireplace doors).

The second test (done at the same time) would establish the equivalent leakage area present in the house, excluding the leakage through the fireplace. This test would be done by taping up the fireplace doors. It would determine how much air leakage there is through the envelope and if provisions for extra make-up air are required. It would ensure that needed make-up air is not necessarily brought in through a leakier fireplace.

## COMBUSTION AIR

by John Timusk

Confusion exists about what is needed to safely vent combustion products from a furnace or a fireplace.

Combustion air is that air required to complete the chemical reaction associated with the combustion of a fossil fuel. Oxygen is required for this process and is available from interior air. Fresh or ventilation air is not needed for this purpose.

The combustion chamber of the fuel burning device has to be designed and built so that the fuel is completely oxidized - otherwise carbon monoxide is produced which is lethal to the occupants of the house. It is difficult to build wood burning devices which provide complete combustion. It is therefore essential that all the combustion products be vented to the outside. For this purpose chimneys are provided. But chimneys are only effective as long as the combustion products move out through the chimney. A chimney can be turned into an air supply opening if the house pressure becomes so low that the natural chimney draft becomes reversed.

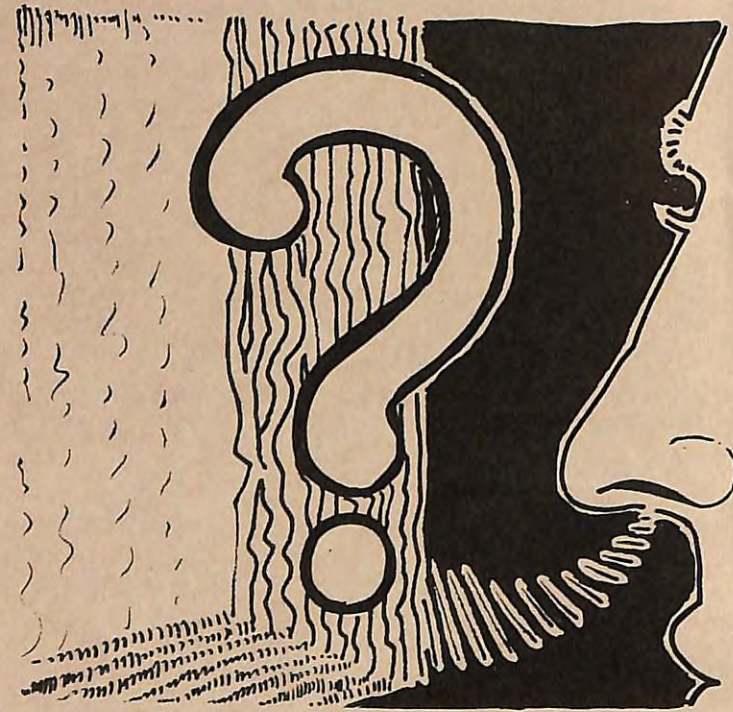
A number of things can cause the chimney draft to be reversed but the lack of combustion air is not one of them. When house pressure is sufficiently low to overpower the chimney draft, the chimney will reverse. If the chimney draft is low, such as can be the case in a low thermal mass (i.e. metal flue) exterior chimney while the fire is dying down, a very small negative pressure in the house can reverse the chimney draft. For this we do not need airtight houses - a house with a second operating chimney, an exhaust fan or two can end up with a sufficiently low negative pressure to reverse a weak draft. This is especially the case if the house is reasonably tight.

For these reasons, all fuel burning devices should be built so that a negative house pressure does not affect the chimney draft. A sealed combustion chamber, combustion and make-up air supplied directly to the combustion chamber and a chamber to lead the combustion products away are required to uncouple the chimney from the house. For wood burning devices this means

making the doors sufficiently tight relative to the air resistance in the combustion and make-up air duct to prevent chimney reversal.

Lack of combustion air can result if combustion products from a fuel burning device are retained in a small enclosure and are reingested by the device, eventually resulting in oxygen depletion and subsequently generating excessive Carbon-monoxide production. Small enclosed furnace rooms could result in this.

*John Timusk is the Chairman, Centre for Building Science, University of Toronto*



## FIBERGLASS: A HEALTH HAZARD?

There is a move in the United States to condemn glass fiber as an insulation material. A group calling itself "Victims of Fiberglass" (VOF) has been formed in California. Regrettably, it has started on the wrong track as its credibility is highly suspect because it is headed by a California businessman who markets a competing product (cellulose insulation).

The campaign launched by the VOF is trying to compare glass fibers to asbestos fibers. They are branding fiberglass a "man-made asbestos". We suspect that you will hear much about this in the next while as a high powered, emotional campaign is launched. The mass media will also jump on the bandwagon (the New York

Times and Globe and Mail have already carried stories on this issue).

We suggest that the source behind the campaign be seriously considered before accepting the message. The emotional tone of the campaign will make it more difficult to rationally evaluate serious research of the potential hazard that fiberglass might represent. It is too easy to take material out of context.

A few epidemiological studies have looked at the risk caused by glass fibers. In some instances exposure to glass fibers has caused cancer in laboratory animals (one test actually mechanically implanted glass fibers inside the lung of the animals). Just how easily these findings can be translated to humans is still uncertain. Some data has been assembled to suggest that workers in a glass fiber manufacturing facility suffered higher incidence of lung cancer than could have been expected. However, this data is far from being conclusive.

Scientists are still skeptical about the seriousness of the potential hazard. More serious research will have to be undertaken to determine the exact nature of the problem.

We do not mean to deny that a problem may exist, but before fiberglass insulation products are condemned, we believe that much research still needs to be done to provide some conclusive evidence.

If fiberglass is truly as bad as is being claimed, we suspect that we would have seen much more evidence of its effects by now. After all, it is a product that has been in use for quite some time now. We should also keep in mind that the toxic effect of many products may be masked or made worse by the presence of other factors. A significant culprit is smoking - this is something that has been conclusively determined recently. There are suggestions that smoking can aggravate otherwise benign foreign agents in our bodies.

Obviously, those exposed to it, such as installers and workers in the manufacturing process should use protective gear at all times. Those who are not exposed, such as the end user (who probably has no exposure once the insulation is covered), should not suffer any consequences as the insulation is well protected within the structure of a building.

## WHERE TO PLACE EMPHASIS TIGHTENING-UP HOUSES

### GETTING THE BEST BANG FOR YOUR BUCK

#### REDUCING HEAT LOSS DUE TO AIR LEAKAGE

Insulation levels in houses have increased considerably in recent years. Building practices and code changes mean that homes are being built with more insulation and tighter than ever before. However, regulations that call for tighter construction have appeared only recently. Heat loss by uncontrolled infiltration and exfiltration through the building envelope is still a major concern, especially in older housing - which consists of the bulk of total housing stock!

We know about this and are now dealing with this issue in new construction (at least those who are building to R-2000 or equivalent standards).

But what about the existing housing stock? Anyone contemplating retrofit work wants to know what the benefits are from sealing a home, and where to devote time, effort and money to most cost effectively reduce air leakage.

A study funded by Alberta Ministry of Energy surveyed the air leakage in 117 Calgary homes (detached, semi-detached, and row houses). The houses were first tested to determine how leaky they were, using standard fan door test equipment.

They found that on average the air change rate at 50 Pascals was 4.31 air changes per hour. Of the various house types, bungalows were tightest (3.91 ACH @50 Pa), while row houses were the leakiest (6.91 ACH @50 Pa). This is approximately equivalent to .3 to .5 natural air changes per hour.

The oldest houses (built before 1946) tended to have the highest leakage, while newer houses (1961-70) had the lowest average number of air changes. Houses finished with stucco or aluminum were the tightest, while woodlap exteriors were leakier.

Although it was found that total glass area in any home had only negligible effect on air change rates, window types have a significant effect. Homes with

wooden double hung windows had higher air change rates (6.07 per hour) than those using casement or awning windows (3.28 ACH).

The number of chimneys, flues and vents that were present in a home was found to have little influence on air change rates.

30 residences were sealed incrementally, and tested at each stage to assess the impact of each air sealing action. The following table indicates, in decreasing order, the components that were sealed, and what impact each had on total reduction in air leakage.

COMPONENT SEALED	REDUCTION (ACH)
CAULK/WEATHERSTRIP WINDOW & DOOR FRAMES, ATTIC HATCH, CAULKING LIGHT FIXTURES	0.28ACH@50PA
BAND-JOIST CAULKING	0.25ACH@50PA
WINDOW GASKETS	0.22ACH@50PA
DOOR WEATHERSTRIPPING	0.18ACH@50PA
PLUMBING STACKS, CHIMNEY CHASE DUCT WORK SEALING	0.17ACH@50PA
CAULKING EXTERIOR	0.08ACH@50PA
BASEBOARDS SWITCH & RECEPTACLE GASKETS ON EXTERIOR & INTERIOR WALLS	0.05ACH@50PA

As the work was done on occupied houses, it was easy to monitor the results, which showed that sealing led to an average gas consumption decrease of 14%. As could be expected, there was a difference in payback periods between those houses where retrofit work was done by the homeowner (who generally doesn't account for his time) and the professionally done job. However, this study provides some guidance in where effort and money should be placed when retrofitting an existing house.

A Survey of Air Leakage in Calgary Homes  
Bill Johnston Architect Ltd.  
302 - 1601 Westmount Rd N.W.  
Calgary, Alta. T2N 3M2 April 1986

## NEW PRODUCT UPDATE:

### HEATMAKER

A new gas fired, sealed combustion, direct vent hot water boiler is now being marketed in Western Canada by J. Stanviloff and Assoc.

The **Heatmaker** unit is an efficient, quiet non-pulsing, non condensing, sealed induced draft combustion boiler that is designed to provide both space heating and domestic hot water.

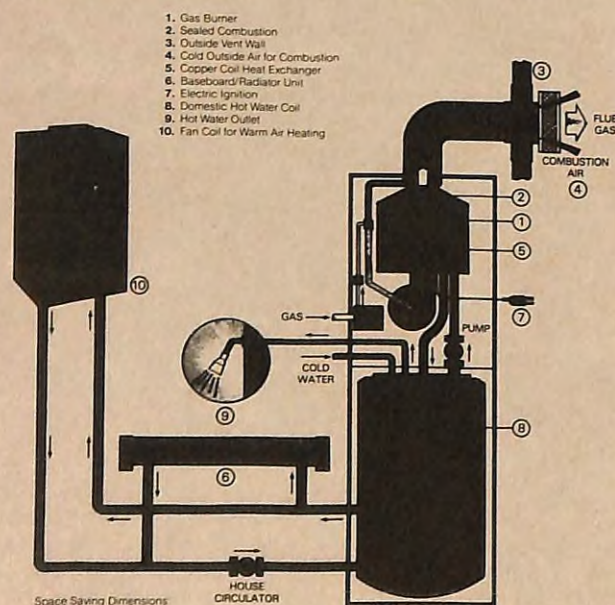
Because the unit uses a concentric flue through a sidewall, chimney flues are avoided. Because it is a sealed air unit, there is no concern about combustion gasses backdrafting into the house.

Domestic hot water is provided on a demand basis. Manufacturer claims flow rates as high as 130 US gal/hr (with 100°F temperature rise).

The unit is a water boiler, that can be set up for low temperature radiant floor, baseboard hydronic, or forced air heating systems.

Two units of interest to the low energy builder are those with a rated input of 60,000 and 100,000 BTU/hr. The manufacturer claims an efficiency rating of 87%.

### HeatMaker™



Space Saving Dimensions:  
HW-Series  
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Covered by U.S. and Canadian patents.  
Other worldwide patents pending.

At a trade price in the \$2000 range, as a combined heating and domestic hot water unit it should be competitive with other furnace/dhw alternatives.

It is manufactured by AMTI Heating Products in Massachusetts, and has CGA approval. In Ontario it is available through utilities.

For information:

J. Stanviloff & Assoc.  
#6 - 120 Glacier St.  
Coquitlam, B.C. V3K 5Z6  
Tel: 604-942-7411

## NEW FROM LIFE BREATH

### LIFEBREATH 300

Nutech Energy Systems Inc. has launched its new **Lifebreath 300** heat recovery ventilator unit.

The unit is a larger version of its **Lifebreath 200 MAX HRV**, which has a removable aluminum core, built-in dehumidistat controls, and variable speed control.

Ontario Research Foundation tests show that at 100 Pascals pressure, the net airflow is 210 cfm (compared to 184 cfm for the **Lifebreath 200**).

Defrosting is handled by an automatic temperature activated timed defrost cycle. It is initiated when the cold supply temperature drops below -8°C. The unit ventilates for about 30 minutes, then defrosts for about 2 1/2 minutes. When in defrost, a damper moves to block the cold incoming air, letting warm house air to defrost the core. Both air streams remain on at all times.

Performance test results at ORF show sensible heat recovery efficiency of 79% at 0°C and 75% at -25°C.  
Information:

Nutech Energy Systems Inc.  
124 Newbold Court, London, Ont. N6E 1Z7  
Tel: 519-686-0797

## LEBCO COMMENTARY

Canada Mortgage & Housing Corp. announced **CMHC2** - a new computer program for calculating cost effective space heating strategies.

The program takes into account the wide range of Canadian climatic conditions and building technologies available, models space heating energy performance and evaluates (in terms of cost-effectiveness) the potential energy use reductions by offering a variety of alternative techniques.

The computer program determines economic implications of specific improvements, using a comprehensive analysis of the building envelope and its climatic environment.

The steps in the analysis are:

- 1) a steady state model of thermal performance (i.e. heat losses at peak design conditions);
- 2) annual losses are calculated one step at a time, on a month by month basis, based on long term weather data;
- 3) an estimate of usable interior gains;
- 4) space heating energy based on net thermal losses and the performance of space heating appliances;
- 5) energy costs are then calculated using local rate structures.

The unique feature of **CMHC2** is the capacity to evaluate the cost effectiveness of specific changes. The program can search out and identify those improvements which may have the greatest economic viability (based on an embedded data base). For this, the user inputs the maximum amount of money he is prepared to spend, and the maximum payback period for the most viable performance improvements found by the program. It results in a ranked list of changes.

The user may request an energy analysis at various stages in the list of alternatives. A simple payback analysis is automatically performed to provide an indication of the worth of a given expenditure.

Sound good? Sound familiar? Except for the financial analysis, much of what the program does is what **HOTCAN** and **HOT2000** have been doing for some time now.

The scandalous thing is that this program was developed in 1983! When it was

presented at the 1983 conference of the Solar Energy Society of Canada, it was explained that it was still in the prototype form (but detailed, multi-coloured printed input forms had been prepared and in use at CHMC head office). Since then, there have been continued references to the program, but it has yet to see the light of day. Distribution and availability have been held back for the the past 4 years!

We are tantalized by the prospects of an exciting new tool. Considerable resources have been devoted in its development, but when are we going to see it put to use? The arguments used by CMHC have been that it is not yet ready for the marketplace.

It seems that someone has forgotten that with software, it is possible to update the program if needed after it's in use (we wouldn't have the large array of software available if everyone waited to come up with the ultimate program).

**HOT2000**, the latest incarnation of **HOTCAN** (which appeared in 1982) is considerably more advanced and refined than the original **HOTCAN** program first developed in Saskatoon. **HOT2000** took a long time to be finalized, yet a form has been in use for these past few years. The widespread use it's getting has helped to refine it and improve it.

Why has CMHC has been sitting on its program, devoting unknown resources to continued refinements?

We raise the issue, because we've just learned that yet another study has been done to do a market assessment. The study found that there are 11 other similar products on the market, all but **HOTCAN** being American.

The study estimates it will take another 8 to 12 months and another \$440,000 to complete product development and packaging. It estimates that the total number of sales will be between 2100-5000 copies (over 3 years) at a cost of \$600, of which about 90% would be sold in the United States. It acknowledges that in the worst case scenario there could be a loss.

We wonder about the wisdom of a public corporation developing a sophisticated piece of software, sitting on it for a number of years, then relying on a foreign market to recover its cost - especially as the product already has some competitors.

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## INTERFACED TUBE TECHNOLOGY

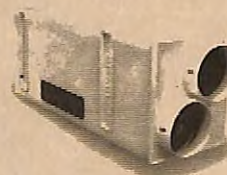


Plate type core design



Interfaced tube core design

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